

Master examination

„Materials Science of Steel – Steel design“

31.08.2015

Name:

Matriculation number:

Signature:

Task	Points:	Points achieved:	Points after review (additional Points)
1	4		
2	8		
3	2		
4	4		
5	2		
6	2		
7	3		
8	4		
9	2		
10	4		
11	5		
12	4		
13	3		
14	3		
Sum	50		

You need 44% to pass the examination. The examination is divided into three parts which have to be passed separately. The final result is calculated as follows:

- 37.5 % Written examination (“Materials Science of Steel”)
- 37.5 % Oral Examination (separate date)
- 25 % Written examination (“Materials Science of Steel –Steel Design”)

Task 1**AHSS****4 Point(s)**

The following kinds of steels are investigated using a light optical microscope:

- TRIP800
- HSLA
- high Manganese TWIP-Steel
- DP600

Sketch the microstructures for each kind of steel. Consider different grain sizes of different phases and label each phase for every sketch. (4 Points)

Task 2**AHSS II****8 Point(s)**

Correlate the 4 given chemical compositions A, B, C and D given in **Appendix 1** with the different steel grades:

- TRIP steel
- HSLA steel
- DP steel

and explain your choice. (8 Points)

Appendix 1

	Wt.-% C	Wt.-% Mn	Wt.-%Si	Wt.-%Al	Wt.-% Nb
Steel A	0,2	1,5	0,1	1,8	-
Steel B	0,1	1	0,5	0,04	-
Steel C	0,07	0,35	0,01	0,04	0.04
Steel D	0,2	1,5	1,5	0,04	-

Task 3**AHSS III****2 Point(s)**

A low-alloyed steel with 0.2 wt.-% C is intercritically annealed.

- a) Explain the term “partitioning”, which is taking place during this intercritical annealing treatment? (1 Point)
- b) After intercritical annealing the steel is quenched. Which microstructure can be observed after quenching? (1 Point)

Task 4**Pipe Manufacturing Techniques I****4 Point(s)**

- a) What is the first basic production step used in the production of seamless tubes broadly called? (1 Point)
- b) Name three typical pipe manufacturing processes that use this basic production step. (3 Points)

Task 5

Pipe Manufacturing Techniques II

2 Point(s)

Name one advantage and one disadvantage of pilger rolling? (2 Points)

Task 6**OCTG****8 Point(s)**

Which microstructural feature is detrimental with respect to sougas stress corrosion cracking (SSCC) in oil country tubular goods (OCTG-tubes) which are alloyed with Mo or Cr. (2 Points)

Task 7**Line pipes****3 Point(s)**

- a) Which media are transported in line pipes? Name at least two. (1 Point)
- b) What are the demands on line pipes based on the geographic environment? Name two different geographic environments and explain which demands are made on the steel used for line pipes. (2 Points)

Task 8**Precision tubes****4 Point(s)**

- a) What is the purpose of an “Autofrettage” treatment and how does this treatment affect the microstructure of the steel? (2 Points)
- b) For which components is the “Autofrettage” treatment necessary. Explain your answer briefly (2 Points)

Task 9**Precision tubes I****2 Point(s)**

Precision tubes are used for applications in automotive engines. Due to rising operation pressure the requirements on diesel injection tubes increase such as:

- Fatigue strength
- Upsetting ability/ flexibility
- Corrosion resistance
- Cleanliness (inner surface)

Name one advantage of precision tubes for two of the previous mentioned requirements on tube steels. (2 Points)

Task 10**Boiler tubes****4 Point(s)**

- a) Name 4 different kinds of materials which are commonly used for boiler tubes. (2 Points)
- b) Which alloying element is used to increase the corrosion resistance of bcc-steels used for boiler tubes? Give the approximate contents of this alloying element for the bcc-steels of task a). (2 Points)

Task 12**deep drawing steels II****4 Point(s)**

Four different Coils A, B, C and D have been processed using the parameters given in Appendix 1. Which coil has the best deep-drawability? Give a short explanation why the remaining 3 coils have a worse deep-drawability. (4 Points)

Processing Parameters	Coil A	Coil B	Coil C	Coil D
Microalloying elements (Ti, Nb, Va) (wt.-%)	0,003	0,075	0,005	0,1
C-Content (wt.-%)	0,003	0,05	0,1	0,005
Coiling temperature (°C)	550	580	560	600
Cold rolling degree (%)	58%	69%	73%	75%

Task 13

engineering steels

3 Point(s)

Name three typical demands on the base materials of gears wheels. (3 Points)

Task 14**rail steels****3 Point(s)**

- a) How does an increased C wt.-% affect the mechanical properties of rail steels? (1 Point)
- b) How does an increased C wt.-% affect the life expectancy and the processability of rail steels? (2 Points)